A COMPARISON BETWEEN TRADITIONAL METHODS AND ARTIFICIAL INTELLIGENCE IN CALCULATING QUANTITIES FOR CONSTRUCTION PROJECTS

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Abstract - This research investigates the comparative effectiveness of AutoCAD, Revit, and Artificial Intelligence (Kreo Software) in quantity surveying within construction projects, focusing on their accuracy, efficiency, and user-friendliness. Quantity surveying, which is essential for managing project costs from estimation to completion, has traditionally relied on AutoCAD. Still, Revit, considered a more advanced tool, and AI is suspected to revolutionize the field. This study employs a mixed-methods approach, integrating qualitative data from a case study with quantitative results from using different software for compression. The findings indicate that, while AutoCAD remains reliable for basic tasks, Revit's BIM integration enhances the accuracy and efficiency of project management. AI, although still in its developmental stage, shows promise in automating calculations and predictive analytics, offering reduced human error and increased productivity. However, its accuracy remains a limitation for its full-scale adoption. The research concluded that the selection of tools is highly dependent on the project's complexity, budget, and specific surveying needs. It offers recommendations for practitioners regarding the most suitable technologies and suggests areas for future research, particularly the further integration of AI in quantity surveying, highlighting the evolving nature of the profession and the importance of embracing technological advancements to optimize construction outcomes.

Keywords - Auto CAD, Revit, BIM, construction, Artificial Intelligence, quantity survey

I. INTRODUCTION

1.1 Background and Context

Accurate quantity surveying is a key component of the success of construction projects, as it is responsible for a fundamental part of estimating construction project costs. Quantity surveyors are responsible for providing accurate data to ensure the accuracy and reliability of project budget estimates.

The duties and responsibilities of quantity surveyors span the entire project lifecycle, from cost estimation and preparation of tender documents in the planning and pre-bid phases, to final settlement of accounts and post-completion reviews during the project closure phase. In addition, quantity surveyors participate in the preparation of cost plans and oversee procurement.

They may also participate in value engineering to reduce project costs without compromising the quality and scope of the project, and they assess potential risks related to quantities and initial estimates. Quantity surveyors are essential in ensuring the financial viability and sustainability of projects, especially in low-profit margin and high-risk projects.

1.2 The Research Objectives

The primary objective of this research is to conduct a comprehensive comparison between three major tools used in quantity surveying within the construction industry: AutoCAD, Revit, and artificial intelligence (Kreo).

AutoCAD, a traditional computer-aided drafting software, is an old and well-known tool for quantity surveyors. In contrast, Revit, a Building Information Modeling (BIM) tool, offers advanced features for integrated project management and is gaining increasing popularity. Artificial intelligence (AI), a new technology, is expected to revolutionize quantity surveying by fully automating quantity surveying processes. This is achieved by using deep learning algorithms to understand structural and architectural plans and calculate quantities in a fully automated manner.

The aim of this research was to evaluate the strengths and weaknesses, and the varying effectiveness of these different tools in performing quantity surveying tasks for the same project. The goal was to provide insights that would help professionals choose the most appropriate tool for different project requirements, thus contributing to improved cost management accuracy and efficiency in construction projects. To achieve this, the project set the following objectives:

- **Functional Capability Evaluation:** Analyze the performance and functionality of AutoCAD, Revit, and AI tools for quantity surveying tasks.
- **Accuracy and Effectiveness Evaluation:** Evaluate the accuracy and effectiveness of various tools in performing quantity surveying activities.
- **User Experience Evaluation**: Evaluate quantity surveyors' user experience with each tool, in terms of ease of use, learning difficulty, and overall satisfaction level.**2. 2. Research Methodology**

This project used a comparative analysis to evaluate the effectiveness of AutoCAD, Revit, and artificial intelligence (Kreo) in quantity surveying for a specific construction project. The primary data sources were architectural drawings and construction plans.

AutoCAD was used to process the project's two-dimensional plans, and quantity surveying was performed by manually calculating quantities.

A 3D model of the project was created using Revit, enabling automatic quantity calculations using the program's built-in features.

As for artificial intelligence, machine learning algorithms embedded in the Kreo platform were used to automate quantity surveying by uploading the structural and architectural plans to the platform.

The accuracy, efficiency, and user experience of each tool were evaluated by comparing the calculated quantities and the time taken to obtain results.

This systematic approach sought to provide a comprehensive understanding of the effectiveness and suitability of each tool for quantity surveying in construction project management.

2.1 The Case Study.

The Al-Narjis Residential Project consists of several identical residential buildings arranged in a linear fashion. As shown in the architectural plan, the case study includes three adjacent buildings.

Each building follows a similar three-story design (ground floor + two upper floors) plus a basement, and contains several residential units designed for family living.

The building layout includes:

Basement: Parking

• **Ground Floor:** Main entrance lobby, living rooms, dining rooms, kitchens, and parking

• **First and Second Floors:** Bedrooms, bathrooms, family rooms, and terraces

• **Circulation Areas:** Central staircases and walkways designed for easy access and safety.

Project Area and Quantities

Building Area: 11905 m^2

Interior Area: 7587 m^2

Exterior Area: 4210 m^2

The interior area encompasses all the ground-level spaces of the buildings. The exterior area represents all the space within the development boundaries. These quantities were calculated as part of the project's quantity surveying and costing process to determine the material requirements for the construction and architectural works.



Figure 1. The project overview.

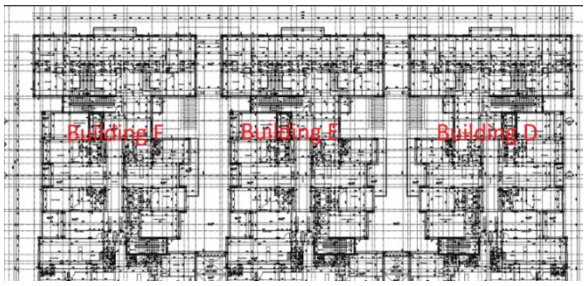


Figure 2. The project plan overview.

2.2 Elements Included in Quantity Surveying

The quantities calculated include the following items:

Structural part:

- Foundations
- Columns
- Slabs
- Beams
- Concrete walls

Architectural part:

- Doors
- Windows
- Flooring
- Walls

III. AUTOCAD IN QUANTITY SURVEYING

AutoCAD, developed by Autodesk Inc., is a computer-aided design (CAD) program and one of the most widely used programs worldwide. It was one of the first programs to change design methods by replacing manual drawing with digital methods. Since its launch in 1982 [1], AutoCAD has undergone numerous updates that have enhanced its capabilities.

Although AutoCAD supports quantity surveying through various add-ins, it still relies primarily on user expertise to determine fine details such as calculating quantities for slopes and changes in elevation. In complex projects with many details, the accuracy of results is often highly dependent on the user's skill and experience.

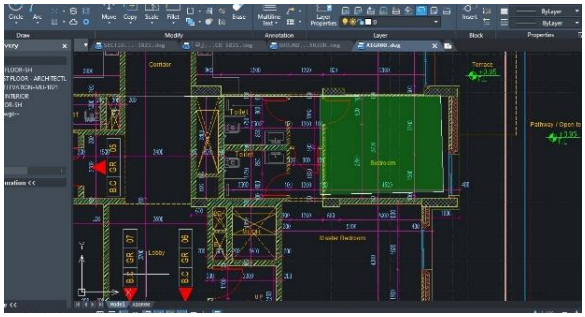


Figure 3. Calculating Areas by AutoCAD.

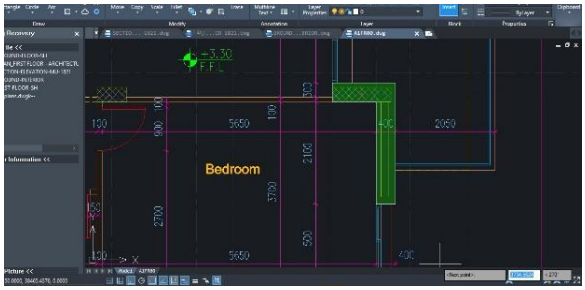


Figure 4. Calculating Walls by AutoCAD.

4. Revit in Quantity Surveying

Revit, developed by Autodesk Inc., is also one of the most advanced building information modeling (BIM) software programs. Since its initial release in 2000 [3], its precise modeling capabilities have enabled accurate and immediate quantity calculations, enhancing the efficiency and accuracy of quantity surveying.

Features and benefits of Revit in quantity surveying:

• Revit's parametric modeling tools enable the creation of intelligent 3D models. These models are dynamic and data-rich, meaning that any modification to the model automatically updates all associated aspects and perspectives [2]. This ensures consistency and accuracy in quantity measurements.

• Revit can perform accurate quantity surveying directly from the 3D model. These automated processes reduce human error and save time, while providing accurate material quantities and cost estimates quickly and efficiently to quantity surveyors. Revit can also create comprehensive material schedules, providing an accurate inventory of all project components, including quantities, dimensions, and other relevant information [4]. These schedules can be customized to meet project requirements, offering a concise overview of the necessary materials.

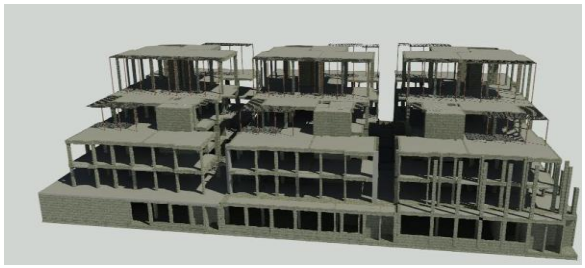


Figure 5. Structural Model by Revit

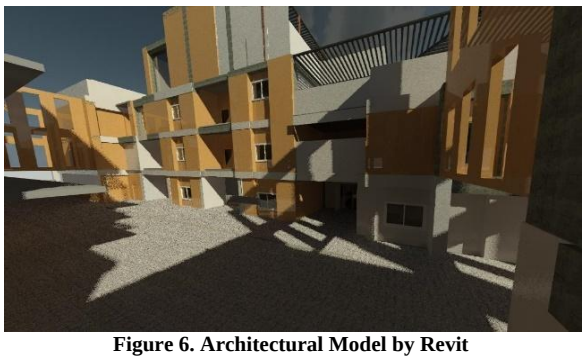


Figure 6. Architectural Model by Revit

The first step is to import the drawing into Revit. This can be done by using the "Import CAD" feature in Revit. Once the drawing is imported, it can be scaled and positioned correctly in the Revit model.

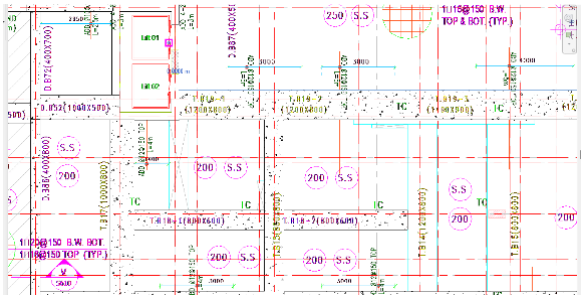


Figure 7. Importing AutoCAD plans into Revit

The next step is to create a foundation, columns, slabs, walls, floors, roofs, doors, windows, and other building elements using Revit's tools. This involves creating 3D objects that match the dimensions and details of the building in the drawing.

First: Structural Model



Figure 8. Raft foundation by Revit

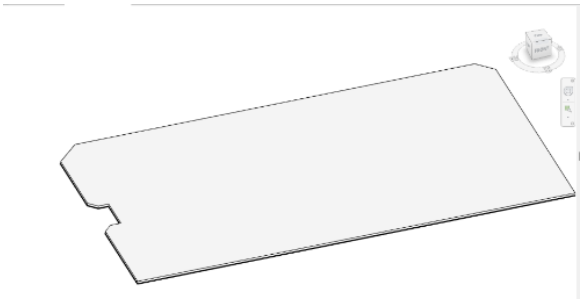


Figure 9.Columns of basement level by Revit

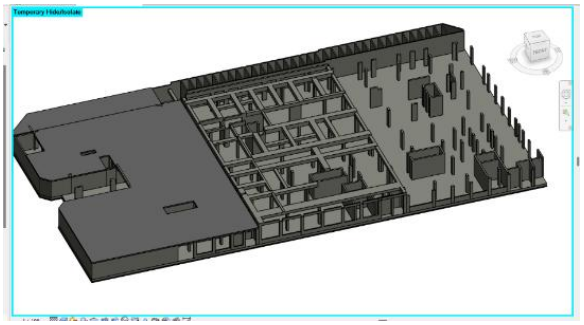


Figure 10.Flat slabs of Ground level by Revit

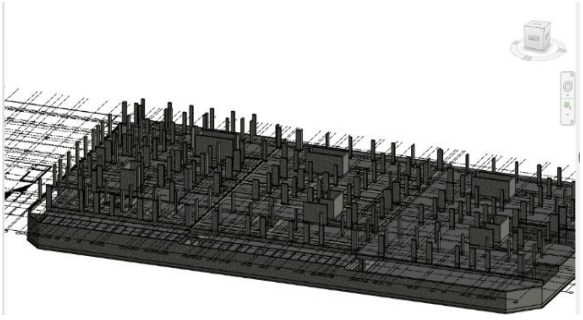


Figure 11.Columns of Ground level by Revit

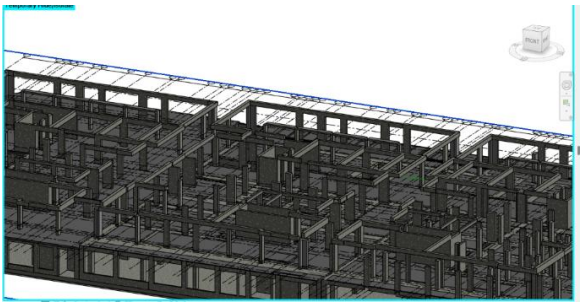


Figure 12.Beams of the first level by Revit

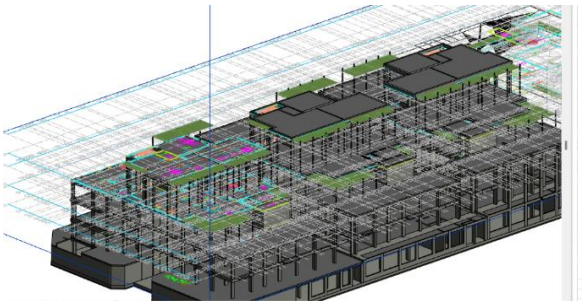


Figure 13.Flat slabs of the Second level by Revit

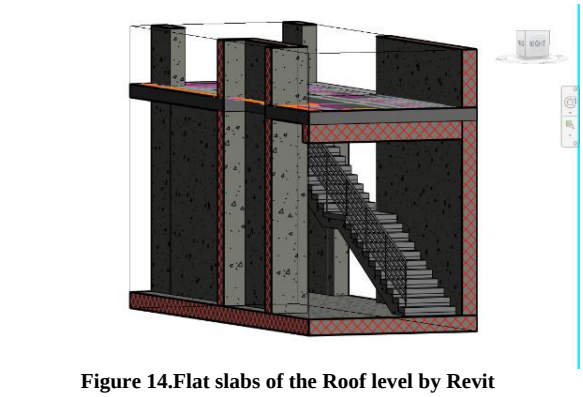


Figure 14.Flat slabs of the Roof level by Revit

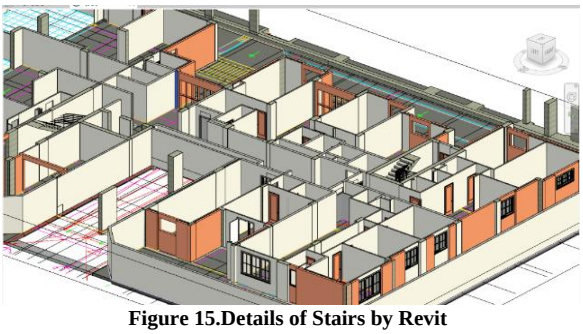


Figure 15.Details of Stairs by Revit

Second: Architectural Model



Figure 16. Architectural details by Revit

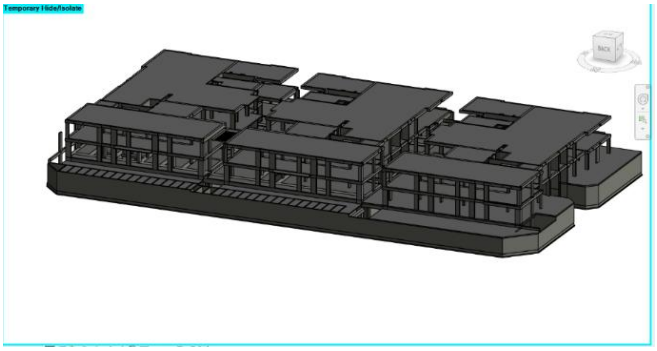


Figure 17.Architectural Model by Revit

V. ARTIFICIAL INTELLIGENCE IN QUANTITY SURVEYING (KREO SOFTWARE)

Kreo Software is a cloud-based software that uses machine learning to help with counting, measuring, and quantity surveys in construction projects.

There were no computer requirements, and no installation was required. Kreo claimsto improve the productivity of cost estimators, planners, and bid managers.

Kreo Software cannot deal with structural elements, it's only available with the architectural part of the project.

Software enables you to upload files in different formats, but files in PDF format give the best results.

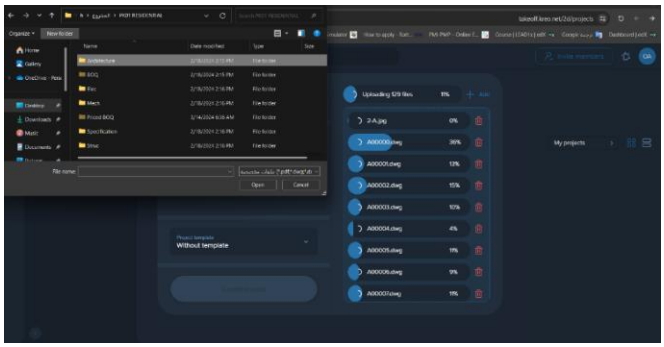


Figure 18.Uploading project files in KREO software platform

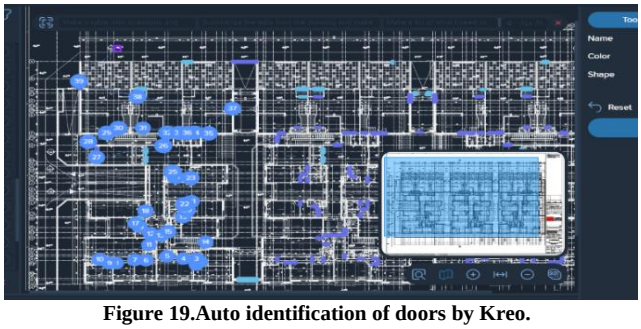


Figure 19.Auto identification of doors by Kreo.

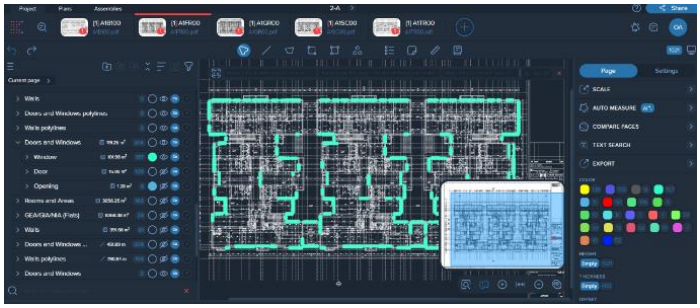


Figure 20. Auto identification of Windows by Kreo

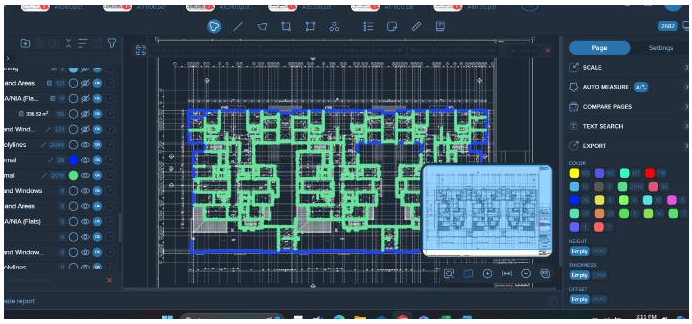


Figure 21. Auto Counting of walls by Kreo

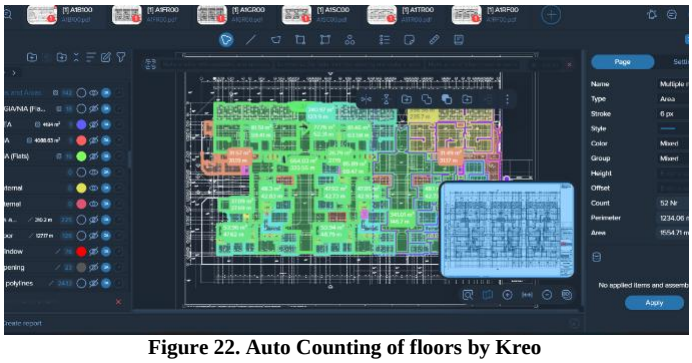


Figure 22. Auto Counting of floors by Kreo

VI. DISCUSSION

The findings illustrate a notable variance in quantity calculations when comparing Revit and AutoCAD; however, since quantity surveying in AutoCAD depends on the operator's ability and experience more than Revit, we can assume this variance in quantity is due to human error in dealing with such a complex project.

The application of artificial intelligence (Kreo Software) proved insufficient in handling the structural elements.

Itemdescription	Quantity AutoCAD[m^3]	Quantity Revit [m^3]	Quantity AI [m^3]	AutoCAD V.S. Revit	AI V.S. Revit
CONCRETE WORKS					
SUB-STRUCTURE					
100 mm Thick Blinding	651.50	770.74	NA	84.46%	NA
Raft Foundation	2,603.36	2,556	NA	101.82%	NA
Basement walls	501.11	659.24	NA	76.00%	NA
Basement Column	220.46	222.12	NA	99.05%	NA

Table 1. Results for concrete work in Sub-structure.

There is still a gap between AutoCAD and Revit that is roughly 20%. Because the origin of these inaccuracies may be attributed, at least in part, to human errors, the disparity between AutoCAD and Revit may be avoided if the quantities were computed by a professional using AutoCAD.

On the other hand, artificial intelligence is unable to perform calculations on the quantities of structural elements or recognize them.

Itemdescription	Quantity AutoCAD[m^3]	Quantity Revit[m^3]	Quantity AI[m^3]	AutoCAD V.S. Revit	AIV.S.Revit
Concrete works					
Super-Structure					
Building F					
200 mm Reinforce-ment Slab	43.45	35.83	NA	120.01%	NA
250 mm Reinforce-ment Slab	122.33	120.78	NA	101.01%	NA
Ground Floor Column	86.46	86.94	NA	98.92%	NA
Ground Floor walls	28.10	36.82	NA	76.05%	NA
First floor					
200 mm Reinforce-ment Slab	133.64	164.74	NA	80.73%	NA
150 mm Reinforce-ment Slab	1.93	1.23	NA	81.30%	NA
250 mm Reinforce-ment Slab	40.65	41.6	NA	96.15%	NA
First Floor Column	64.19	61.15	NA	104.66%	NA
First Floor walls	31.34	36.82	NA	84.19%	NA
Second floor					
200 mm Reinforce-ment Slab	133.75	161.84	NA	82.18%	NA
150 mm Reinforce-ment Slab	1.05	1.12	NA	89.29%	NA
250 mm Reinforce-ment Slab	37.64	32.44	NA	114.06%	NA
Second Floor Column	37.70	31.32	NA	118.14%	NA
Secondfloor walls	36.26	34.42	NA	104.59%	NA

Table 2. Results for concrete work in the super-structure

Table 2 continued

Itemdescription	Quantity AutoCAD [m^3]	Quantity Revit [m^3]	Quantity AI [m^3]	AutoCAD V.S. Revit	AI V.S. Revit
Concrete works					
Super-Structure					
Building F					
Roof floor					
200 mm Reinforce-ment Slab	152.15	134.77	NA	112.78%	NA
150 mm Reinforce-ment Slab	1.04	1.20	NA	83.33%	NA
250 mm Reinforce-ment Slab	15.91	13.12	NA	114.33%	NA
Roof Floor Column	14.64	18.29	NA	76.54%	NA
Roof Floor walls	17.49	15.22	NA	111.70%	NA
Top roof floor					
200 mm Reinforce-ment Slab	55.37	54.22	NA	101.44%	NA

Table 2. (continued): Results for concrete work in the super-structure

When it comes to architecture elements, the significance of artificial intelligence was brought to light, particularly in the process of determining the number of doors and windows. Even though the findings were not exact, they appear to be quite direct when compared to the amount of time it took to achieve them. All the findings obtained from AutoCAD and Revit were similar, and any differences that were seen in the process of acquiring these results may be attributed to human mistakes or faults.

As shown previously, AI (KREO software) enables to performanceof calculations on the quantities of architectural elements of the project; however, as shown in the next photos, the result cannot be reliable all the time and needs to be reviewed manually

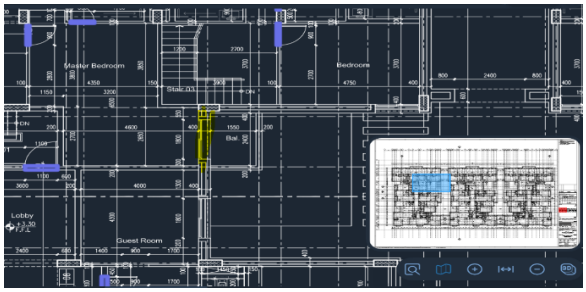


Figure 23. Kreo software failed to recognize the sliding doors

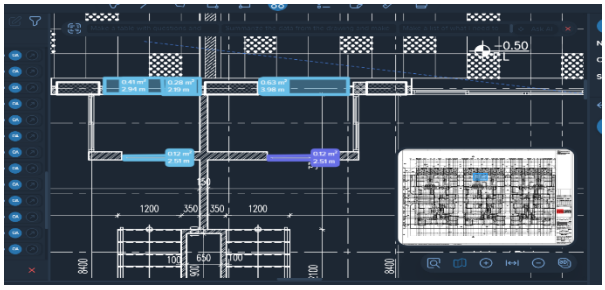


Figure 24. Kreo softwarerecognizes the same element as a Window and a door

Item description	Quantity AutoCAD[unit]	Quantity Revit[unit]	Quantity AI[unit]	AutoCAD V.S. Revit	AIV.S. Revit
Architectural					
Windows					
Building E					
Ground floor					
610 x 1830mm	18	20	22	90.00%	75.86%
1500 x 1200mm	6	6		100.00%	
1550 x 650mm	5	3		166.67%	
First floor					
1500 x 1200mm	2	1	31	200.00%	100.00 %
915 x 1830mm	12	13		92.31%	
1500 x 1200mm	4	2		200.00%	
406 x 1830mm	1	1		100.00%	
915 x 1830mm	8	7		114.29%	
1500 x 1200mm	5	4		125.00%	
1800 x 800mm	1	3		33.33%	
Second floor					
915 x 1830mm	4	6	34	66.67%	136.00%
1800 x 800mm	4	2		200.00%	
915 x 1830mm	12	15		80.00%	
1500 x 1200mm	4	2		200.00%	
Roof floor					
2000 x 3600mm	10	10	19	100.00%	190.00%

Table 3. Results for architectural work –Windows

Item description	Quantity AutoCAD(unit)	Quantity Revit(unit)	Quantity AI(unit)	AutoCAD V.S. Revit	AI V.S. Revit
Architectural					
Doors					
Building D					
Ground floor					
6'8 Door	4	4	43	100.00%	126.47%
8' Open	1	1		100.00%	
D 2	1	1		100.00%	
D 3	10	10		100.00%	
D1-DoorInteriorSinglePanelWood	18	18		100.00%	
First Floor					
6'8 Door	1	1	46	100.00%	102.22%
D1-DoorInteriorSinglePanelWood	6	6		100.00%	
6'8 Door	3	3		100.00%	
D2-DoorInteriorSinglePanelWood	18	18		100.00%	
D3-DoorInteriorSinglePanelWood	17	17		100.00%	
Second Floor					
6'8 Door	1	1	26	100.00%	83.87%
D1-DoorInteriorSinglePanelWood	3	3		100.00%	
6'8 Door	3	3		100.00%	

D2-DoorInteriorSinglePanelWood	9	9		100.00%	
6'8 Door	1	1		100.00%	
D3-DoorInteriorSinglePanelWood	14	14		100.00%	

Table 4. Results for architectural work -Doors

Table 4 continued

Item description	Quantity AutoCAD (unit)	Quantity Revit (unit)	Quantity AI(unit)	AutoCAD V.S.Revit	AI V.S. Revit
Architectural					
Doors					
Building D					
Roof floor					
6'8 Door	1	1	12	100.00%	100.00%
6'8 Door	2	2		100.00%	
D1-DoorInteriorSinglePanelWood	9	9		100.00%	

Table 5.(continued):Results for architectural work -Doors

Artificial intelligence (KREO software) was unable to recognize the boundaries of the building, the rooms, and the different sorts of categories when it came to the architectural aspect of the project. It is impossible to say that the outcomes produced by AI were believable or dependable in any manner. The findings for Revit and AutoCAD were quite comparable to one another.

Item description	Quantity AutoCAD[m^2]	Quantity Revit[m^2]	Quantity AI [m^2]	AutoCAD V.S. Revit	AI V.S. Revit
Architectural					
Floors					
Building E					
Ground Floor					
Outdoor Floor	502.33	473.9	2076	106.00%	152.71%
Wood Joist 220mm WoodFinish	814.66	885.5		92.00%	
First Floor					
Outdoor Floor	45.36	43.2	1589	105.00%	174.08%
Wood Joist 220mm WoodFinish	878.296	869.6		101.00%	
Second Floor					
Outdoor Floor	309.87	281.7	1273	110.00%	140.85%
Wood Joist 220mm WoodFinish	671.868	622.1		108.00%	
Roof floor					
Outdoor Floor	498.576	488.8	801	102.00%	112.99%
Wood Joist 220mm WoodFinish	239.909	220.1		109.00%	

Table 6. Results for architectural work –Floors

An examination of the similarities and differences between AutoCAD, Revit, and Artificial Intelligence (KREO software) in the field of quantity surveying revealed that there are significant differences in terms of precision, productivity, and the requirements for resources.

Due to thecomprehensive Building Information Modeling (BIM) features of Revit, it has been demonstrated to be the most accurate tool for computing values.

Despite this, obtaining this level of precision required a significant amount of effort, which amounted to almost seventy hours, as well as the utilization of high-performance computing resources, as shown next Table.

Although it is less precise than Revit, AutoCAD offers a workflow that is both faster (by around 30 hours) and more direct. As a result, it is best suited for projects that are less complicated or for situations in which time constraints are imperative.

Artificial intelligence had the fastest processing rates (more than twenty hours), but it lacked the precision that was required for reliable quantity surveys.

Feature	**Revit**	**AutoCAD**	**Kreo Software**
Operating System	Windows 10/11 (64-bit)	Windows 10 / 11 (64-bit)	Windows (version not specified)

CPU	Intel i-Series / Xeon / AMD Ryzen(2.5+GHz)	2.5+ GHz (3+ GHz recommended)	Not specified
Memory (RAM)	32 GB	8 GB (16 GB recommended)	Not specified
Display Resolution	Min:1680×1050, Max: 4K UHD	Up to 3840×2160	Not specified
Video Adapter	DirectX 11, Shader Model 5, 4 GB VRAM	Not specified	Not specified
Disk Space	30 GB	10 GB (SSD recommended)	Not specified
Internet Required	Yes	Yes	Yes

Table 7. The table shows computer system requirements for the different software (source: Autodesk websitehttps://www.autodesk.com/, Kreo software websitehttps://www.kreo.net/)

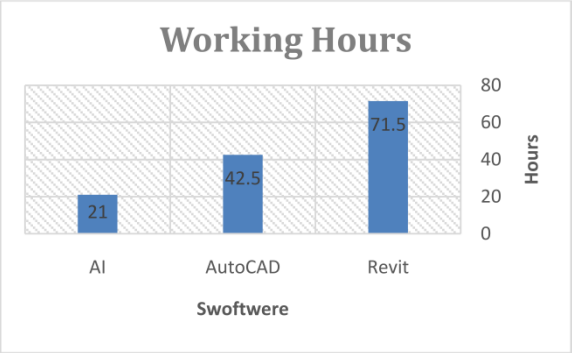


Figure 25.Compare the working hours to complete the calculation of quantities for the same project in the case study.

VII. APPLICATIONS FOR THE INDUSTRY

These findings have significant implications for the construction sector, particularly regarding the selection and use of quantity surveying software. Revit has demonstrated high accuracy, making it well-suited for complex projects requiring extreme precision. Its ability to integrate comprehensive data into a model allows it to provide accurate quantities and minimize errors. However, the time required to build the model in Revit, along with its high computing power and skilled operator demands, may limit its effectiveness for smaller companies or projects with tight deadlines.

On the other hand, AutoCAD strikes a balance between moderate accuracy and speed in quantity surveying, making it a practical choice for simpler projects or early project phases requiring rapid estimates. Its lower computing power requirements also make it accessible to a wider range of users. However, users must be aware of AutoCAD's accuracy limitations. Failure to recognize these limitations could lead to increased costs. The potential of artificial intelligence in quantity surveying lies in its speed and lack of computational requirements beyond internet access, significantly reducing the time needed for quantity calculations. Artificial intelligence (AI) is characterized by its ease and speed, making it suitable for initial approximations or tasks where speed is more important than accuracy. However, the current inaccuracies associated with AI necessitate further development and refinement before it can be reliably used for precise and final quantity surveying.

In short, Revit offers unparalleled accuracy and is best suited for complex projects requiring meticulous detail. AutoCAD provides a faster and easier-to-use option for simpler and intermediate tasks. AI remains an evolving technology that requires further development to achieve the necessary accuracy for critical quantity surveying. Ultimately, the choice of tool depends on the specific needs and constraints of the project, including the required accuracy, available resources, and project timelines.

VIII. FUTURE RESEARCH

Further research is encouraged into the rapidly evolving capabilities of AI in quantity surveying. If AI technology continues to grow at its current pace, it could become even more accurate and reliable, making it a more competitive alternative. Furthermore, research focusing on hybrid methodologies that combine the advantages of Revit, AutoCAD, and AI may provide a significant avenue for developing more efficient and accurate quantity surveying systems.

By integrating different tools within a common workflow, new efficiencies and best practices for the construction sector can be discovered.

IX. CONCLUSION

An analysis of the similarities and differences between AutoCAD, Revit, and artificial intelligence (KREO software) in quantity surveying was conducted. Based on the results of this comparison, each tool had its own set of advantages and disadvantages. Revit emerged as the most accurate software based on its comprehensive Building Information Modeling (BIM) capabilities. It achieved this because it was able to provide large amounts of detailed and accurate data. On the other hand, if this level of accuracy requires significant time and computing power, it would be less feasible for more time-sensitive or smaller projects.

AutoCAD's advantages included being not only faster but also less complex and easier to use, while maintaining a good level of accuracy. It proved suitable for projects that did not require the same

level of complexity. Artificial intelligence did not provide the required accuracy for reliable quantity surveying, although it demonstrated faster processing speeds compared to the other methods. These results highlight the importance of selecting the appropriate tool based on project requirements, striking a balance between the desired level of accuracy, time constraints, and available resources.

Future advancements in artificial intelligence are likely to enhance its accuracy, potentially making it a more viable option for large-scale quantity surveying. This is a potentially positive and beneficial development.

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